Magnetic Particle Imaging: A Novel Ultra-sensitive Imaging Scanner for Tracking Stem Cells In Vivo

Grant Award Details

Magnetic Particle Imaging: A Novel Ultra-sensitive Imaging Scanner for Tracking Stem Cells In Vivo

Grant Type: Tools and Technologies I

Grant Number: RT1-01055

Investigator:

Name:	Steven Conolly
Institution:	University of California, Berkeley
Type:	PI

Human Stem Cell Use: Embryonic Stem Cell

Award Value: $858,345

Status: Closed

Progress Reports

Reporting Period: Year 1

View Report

Reporting Period: Year 2

View Report

Reporting Period: NCE - CANCELLED

View Report

Grant Application Details

Application Title: Magnetic Particle Imaging: A Novel Ultra-sensitive Imaging Scannerfor Tracking Stem Cells In Vivo

Public Abstract:

We aim to develop, test and validate a new, sensitive and affordable scanner for tracking the location of injected cells in humans and animals. This new scanning method, called Magnetic Particle Imaging, will ultimately be used to track the location and viability of stem cells within the human body. It could solve one of the greatest obstacles to human hESC therapy---the ability to track stem cells and see if the cells are thriving and becoming a fully differentiated cell that can improve function of damaged organs.

All of the current imaging methods used to track stem cells have significant problems when tracking stem cells through a living mouse or human. MRI is too insensitive and expensive. Optical imaging methods (fluorescence and luminescence) are useful for cell studies under a microscope, but they cannot produce high resolution images when the labeled cells are deeper than about 1 cm. Nuclear imaging methods involve radiation and offer poor spatial resolution. Ultrasound has many obstructions and the gas bubble stem cell tags do not persist very long. Hence, we wish to develop a new imaging method tailored for tracking stem cells in the human body---Magnetic Particle Imaging. Magnetic Particle Imaging should be 200x better sensitivity compared to MRI and it is simpler and significantly less expensive. Only developed in the last 3 years, Magnetic Particle Imaging scanners are not available commercially. The method uses FDA-approved contrast agents that are nanometer-scale magnetic cell tags. Our initial tests show great promise since we were able to create 1 mm resolution images with 100 nanogram detection limits. We plan to improve that detection limit to 100 picograms, which would translate to detecting just 10 cells anywhere within a mouse. Ultimately, we believe that single cell detection will be feasible with Magnetic Particle Imaging.

Statement of Benefit to California:

Stem cell therapy has enormous promise to become a viable therapy for a range of illnesses, including cardiovascular disease, diabetes, stroke, and Alzheimer's. If we could expedite the development of these therapies, it would be of enormous benefit to both the citizens of the State of California, since they and their relatives would enjoy far less disability. Moreover it would greatly reduce the Medical costs for the State. The diseases mentioned above are the leading cost illnesses as measured in lostproductivity, lost wages, and extended care of the disabled. In fact, a study of the 1987 National Medicaid Expenditure Survey and the 2000 Medical Expenditure Panel Survey showed these diseases featured prominently in the top 15 most costly medical conditions: (1) cardiovascular disease (8%); (4) cancer (5%); (5) hypertension (4%); (7) cerebrovascular disease (3.5%) (9) diabetes (2.5%). A key obstacle to stem cell therapy is the inability to track stem cells through a human body. This means that there is no way (other than measuring organ function) to determine how well the therapy works. Considering the number of delivery methods and the number of challenges to getting stem cells in place, and then coaxing them to differentiate and improve organ function, it will be impossible to optimize the entire process without intermediate imaging feedback to optimize each step independently. Unforunately there is no acceptable method now for tracking stem cells throughout the human body. The new method, called Magnetic Particle Imaging, to be developed in this research does offer a way to track stem cells. Moreover, it will be inexpensive and quite simple to operate. The research requires a collaboration between imaging bioengineers, stem cell biologists, and cardiologists. Fortunately, we have been able to form such a team between [REDACTED] and [REDACTED]. Hence, we are very excited to begin this research so the basic imaging tool will be available to expedite the complex stem cell therapy research so critical for the State of California and its citizens.
